A
New DISCOVERY
For Finding the
LONGITUDE.

Humbly Submitted to the

Approbation of the Right Honourable
the Lords Spiritual and Temporal, and
the Reſt of the Honourable Perſons,
appointed by the late *Act of Parliament*,
for Hearing and Determining *Propoſals*
relating to the ſaid LONGITUDE.

By William Hobbs, *Philo Mathem.*

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LONDON:
Printed for the Author, and are to be Sold by *Fard.*
Burleigh in *Amen-Corner*.
Price Six-pence.

Note, The former Impreſſion was Printed *July* 12. 1714.

27. July.

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A New Diſcovery for Finding the Longitude.

FOR Finding the Longitude, it is to be noted, That if the true Hour, and Minute of the Day, at the Place of our firſt Departure, and where we are Arrived, can be both obtained; the Difference of Longitude may be found, as truly as the Difference of Latitude.

For which purpoſe the *Spring-Movement* hereunto ſubjoined, is moſt humbly propoſed to effect the ſame, even to the Tenth of a Minute of Time. So that ſhould the Error of a Minute happen to be found in Practice, it muſt proceed from the Influence or Viciſſitude of the Air, and not from any Defect in the Rules by which the ſaid Movement is compoſed, as will plainly appear by the Explication thereof, in the following Lines; and firſt of

The Deſcription of the ſaid Movement.

This Movement may be either of the Form and Bigneſs of that in a Common Clock; or elſe of the Smallneſs of a Pocket Watch, as may be thought convenient in Practice. But the larger it is, the better the Diviſions in the *Horologe* will appear. And as for the Numbers, they may be at pleaſure: Only this muſt be obſerv'd, That the ſwifteſt Index muſt make juſt One Revolution, whilſt the ſlow one goes but One of the Hundred Diviſions, (as is common in Minute Watches, wherein 60 Minutes goes to an Hour) but the reſt of the Numbers may be at pleaſure, as aforeſaid. And if the Sloweſt moves round in 3, 4, or 5 Days; and the Movement requires to be wound up once in 26 or 27 Hours, it will be ſufficient: For the more Vigor the Motion is calculated for, the leſs the Air will affect it.

How to ſet it firſt in Motion.

When it is finiſhed, let it go for a Month or two; after which put the two *Indexes* right one with the other, and both of them pointing juſt to 100. Then the Spring being wound up, keep it from Going (with the Key) till the Shadow of the Sun is exactly come to a *Meridian* Line, which muſt be rightly prepared for that purpoſe. Then let it go till the Shadow comes juſt to the ſame Line the next Day, or rather 40, 50, or 100 Days after, (the longer the Better.) At which time enter down the *Centeſims* that the ſwifteſt *Index* points to, as alſo the *Integers* and *Tenths* of the ſloweſt, (but put the laſt firſt in your Numbers) by this you will be furniſhed with two general Numbers, *viz.* the ſaid Numbers pointed to, and the Time (in Hours) ſpent therein, to find the Hour of the Day to the Tenth of a Minute, at any time; for that Place where it was ſo ſet going, tho' you remove it afterwards to any Diſtance whatſoever. Which two Numbers ought to be entered in a Book; to be uſed whenſoever you would find the Hour of the Day.

And it is to be noted, That if the Sun be not then in its Mean Motion, you muſt Add to, or Subſtract from what the *Indexes* do Give, according to the Inequality thereof: But if you try it for one whole Year, there will be no need of either. And that what is ſaid may be the better underſtood, I ſhall give an Example.

How to find the Hour and Minute of the Day at London, *by the ſaid Movement.*

Suppoſe it ſhould be made for the Sloweſt to Revolve in about five Days, and after it has gone juſt two Days, the Sloweſt *Index* ſhould then point between 39 and 40, and the Swifteſt to 21.5. Then both theſe Numbers (as ſet in Order) will make 3921.5. And if the Sun be in its Mean Motion (if not, you muſt Add or Subſtract, as aforeſaid) then the ſaid Numbers 3921.5 muſt always be the Firſt; the ſaid two Days, or 48 Hours, the Second; and the two Numbers pointed to by the *Indexes*, at the time for which you would find the Hour and Minute of the Day (as ſuppoſe the ſlow one ſhould point to 87, and the ſwift one to 65.2, both making 8765.2) muſt be the Third; by which the Fourth will be obtained as followeth: Which Fourth Number being Divided by 12, the Remainder will be the Hour and Minute of the Day at *London*, as was required.

Hours Hours.
As 3921.5 : 48 : : 8765.2 : 107.18
ho. min.
Remains 11 : 10.8 } Requir'd
hours.
or 11$\frac{18}{100}$

And ſo for any quantity of time leſs than one Revolution.

But if the time required to find the Hour and Minute at *London*, (when at Sea or Land,) be ſome Weeks or Months, *after* it was firſt ſet going; or (if cleanſed) after it was laſt *Cleanſed*; then you muſt add 10000.0 to what the two Indexes do ſhew, for each *Revolution*, that it has made, ſince it was ſo ſet going, or laſt cleanſed. And if you would at any time know how many ſuch Revolutions muſt be added, to what is ſhewn by the Horologe; you muſt firſt note the *Day* of the Month, that you are then ſeeking the Hour for; as ſuppoſe *Novem.* 12. 1715. After which note the *Day* laſt entred, when cleanſed; as ſuppoſe *Sept.* 5. 1715. Then compute the number of Days between *Sept.* 5. and *Novem.* 12. which is 25, 31, and 12, In all 68. After which obſerve the *Time* laſt ſpent in one Revolution; which you ſee was 5 Days, 4 Hours, and $\frac{1}{8}$ (for which ſet down $\frac{1}{10}$ for 'twill make no ſenſible Difference) and having thus done, ſay,

Days Hours Hours Revo. Days
As 5 4$\frac{1}{8}$ equal to 124.1 : 1 : : 68 : 13. whole Revolutions;

For which, as before directed, you muſt add 13 times 10000.0 to the Numbers pointed to, by the two Indexes: Which if we ſuppoſe 3752.2 making in all 133752.2 will be the Number required, for the 12th of *November*, if the Indexes ſhould both point as before propoſed. And having now found this Number, you are prepared to find the Hour and Minute at *London*, in manner following (*viz.*) ſuppoſe you are in or near 44 Degrees of Latitude, in the Autumn Seaſon. Then ſeek the Latitude 44 Deg. and the Seaſon *Autumn*, in the Book that is peculiar to your Movement, and having found both, take the Numbers Anſwering thereunto, which (in this Example) is 29274.2 and 240 Hours; and then ſay,

Hours Hours
As 29274.2 : 240 : : 133752.2 : 1096.84 Which being devided by 12, leaves remaining 4.84 ho. or 4 ho. 50.4 min. required, for the Hour and Minute at *London*, by which the Longitude will be found, as before directed.

And ſeeing it was near the Winter Seaſon: If you ſhould add the Autumn and Winter Numbers, and Hours reſpectively together; and make them the two firſt Numbers in your Proportion; it would Æquate the Seaſons more exactly: I mean, if the ſaid Numbers had been really entred from Practice; but theſe are only ſuppoſed. And by this method you may Æquate the Numbers for finding the true Hour and Minute at any Seaſon; or for any other Latitudes whatſoever.

How to find the Hour and Minute, at the place where you are, when abroad, either at Sea or Land.

For Solving this, there are Two Ways, the Firſt and Infallible is, when the Sun is either Riſing or Setting; at which times, if the Air be clear, obſerve what Numbers are pointed to by the two *Indexes*, (but obſerve the ſwifteſt firſt, becauſe it will ſoon be removed) juſt as the Center of the Sun is in the Horizon; and enter both the Numbers down, as before directed, with the Day of the Month, and the Latitude you are then in: Which having done, by the following Cannon, ſay,

As ℞
Is to t. c. of the Sun's Decl.
So is t. Lat.
To ſ. c. of an Angle; which, if converted into Time (by 15) Gives the Hour and Minute of the Sun's Riſing from Midnight; and if Subſtracted from 12 ho. gives the Setting. Which ſhews the true Hour and Minute at the Place where you then are, either at Sea or Land.

The Second way for Solving the ſaid Queſtion, is by taking the Sun's Altitude, when about 5 or 10 degrees above the Horizon; and at the ſame time let another Perſon ſee what Number the Swifteſt Index points to, and after that the Sloweſt: Then put them both down as before directed, with the Day of the Month, and the Latitude of the place where you are; then have you the Sun's *Altitude*, the ſaid *Latitude*, and the Sun's *Declination*, to find the Hour and Minute of the Day at the place required.

Now having by the ſaid Obſervations and Cannons found the Hour and Minute of the Day for the Place where you are, when abroad; and by the Numbers pointed to, by the two Indexes, alſo found the Hour and Minute that it is at *London*, (if the Movement was there ſet going;) If you take the Leſſer of theſe from the Greater, and bring the Remainder

mainder into Minutes, it will give the difference between the two places in Time; by which you may find their difference of Longitude either *Eaſt* or *Weſt* to a Minute, by the following proportion, (*viz.*)

Suppoſe the Difference of Time was 37 Minutes, then ſay,

As	Minutes of Time 1440. or 24 hours	:	Minutes of Longitude 21600.	::	Minutes of Time 37	:	Minutes of Longitude 555.5 Deg. Min. or 9 : 15.5 Required.

Which 9 deg. 15.5. min. being added to, or taken from the Longitude of the Place, where the ſaid Movement was firſt ſet in Motion, gives the Longitude you are come into, as effectually as the Latitude is obtained by Obſervation, as was at firſt propoſed. So that it is evident, that if any defect ſhould be found in practice, it muſt proceed from the Viciſſitude of the Air; and not from any Deficiency in this Diſcovery, or from the Cannons relating thereunto.

And that we may Anſwer all *Objections*, which may ariſe, on Account of the ſaid Viciſſitude of the Air, Motion of the Ship, Foulneſs of the Movement, *&c.* as well as render this Diſcovery more intelligible, we will deſcend to ſpeak thereof more particularly: And,

In the firſt place, let Five or Six (or what Number you pleaſe) of theſe Movements be made; and after they have gone for a Month or two, (or if deſigned for the Sea, 'till within two or three Weeks of your Sailing) then take them aſunder, and ſet them going by the *Meridian* Line, as before directed. And having entred down in the Book, herein after mentioned, the Day of the Month, when ſet going; how long it is making one Revolution; and what Number is produced, in juſt Ten Days Motion, (all which muſt be done, before you Sail in every Voyage;) Let them be carry'd to Sea, into any Latitude, (ſuppoſe 50 Deg. or *Newfoundland*) and at their Return bring them again to the ſaid *Meridian* Line, and thereby (with the help of the Number of Days from their being firſt ſet in Motion) find the two firſt Proportional Numbers, as before directed: Which done, enter them in a Book, peculiar to each Movement, (the Form whereof followeth) together with the Latitude, and Seaſon of the Year in which the Voyage was made. Then will they all be fitted for a Voyage to *Newfoundland*, and Parts adjacent, for any ſuch Seaſon. And ſo for any other, when Tried and Entred, as now directed.

After which, ſend them all in a Ship bound to the Latitude of about 37 Deg. (ſuppoſe *Virginia*); and being returned, let the Numbers be found and entred, as aforeſaid, with the Latitude and Seaſon; then will any one, or all of them, be fitted for a Voyage, either to *Newfoundland* or *Virginia*, or any of thoſe Parts, for any ſuch like Seaſon; and ſo for any other, when Tried and Entred as aforeſaid.

This being done, ſend them alſo in a Ship, bound to the Latitude of 13 Deg. (ſuppoſe *Barbados* or *Jamaica*;) and being returned, find the Numbers, and enter them with the Latitude and Seaſon: So will they all be fitted for theſe ſeveral Latitudes, (*viz.*) 50 Deg. 37 Deg. and 13 Deg. at ſuch a Seaſon: And by a like Proceſs to the *Æquinoctial*, and towards the *North Pole*.

Upon which ſeveral Tryals, you will have ſo many Movements fitted for all the *North Hemiſphere*, both for Hot, Cold and Temperate Seaſons. And, by only Counterchanging the Latitudes, for the whole Globe; or at leaſt for the Marine Parts thereof.

And to what is propoſed to be Entred, in reſpect of Latitude and Seaſon, you may alſo add the Time of its being firſt ſet in Motion after Cleanſing; which Cleanſing muſt be done only Annually, and as near as may be on the ſame Day of the Month; which will much facilitate the Inequality ariſing from its Foulneſs: By which all Objections will be anſwer'd, and the Diſcovery render'd compleat and perfect. Eſpecially if a true *Meridian Line* be made in every conſiderable Port in this Kingdom, and elſewhere; for Examining the Movement at your Arrival abroad, and ſetting it in *Motion*, before your Departure. But remember, that where you ſet it going, from thence your *Departure* muſt be reckon'd.

And by this Method all the ſaid Viciſſitudes that may ariſe in reſpect of Latitude or Seaſons, Motion of the Ship (which will be near the ſame in one Voyage, as in another) and Cleanneſs or Foulneſs of the Work, will alſo plainly appear upon Record, (by comparing one Number in the ſaid Book with another) and will be Accounted for, and Æquated, as occaſion requires: Namely, by only taking ſuch Numbers from the ſaid Book, to work your Proportion by, as are entred for the Latitude and Seaſon, that you are again Arrived to, or Sailing under: As ſuppoſe into 50 Deg. in the Summer Seaſon, then take the Number and Hours anſwering thereunto; and ſo, if in Winter, thoſe for the Winter. By which proportionable Numbers, the ſaid Contingencies will be truly and effectually Allowed, and the Difference in Motions juſtly Æquated, as was before aſſerted.

Note

Note, That in this Movement, the Time is Regulated or Conformed to the Motion: Whereas in former Movements, the Motion is Regulated or Conformed to the Time. And this ought to be well underſtood, before you can rightly comprehend what is herein contained.

Now that this Movement, or Diſcovery, does not only differ from, but alſo far exceed, any that has hitherto been propoſed; is evident in this (*viz.*) That if any former Movement whatſoever be Timed here, as uſual, Before it is carried to Sea, (tho' never ſo exactly) yet the change of Climate, *&c.* will ſo affect it, as to make it go Falſe: And if you fit it there, then 'twill be alſo Falſe when brought hither: But if by this Movement, and the foregoing Rules, the ſaid Numbers be found After it is returned from ſuch a Voyage; all the ſaid Defects or Contingencies will be Æquated by the ſaid Numbers only. So that it will be the ſame in uſe, as if no ſuch Accidents did attend it at all. And this Aſſertion muſt, and will be granted, by every one that does fully comprehend the Nature and Uſe thereof. For altho' this *Horologe* has no certain *Hours* or *Time* pre-aſſigned to it; yet it hath nevertheleſs, greater or leſſer Numbers Æquated to the Variableneſs of Motion or Time, (*viz.*) If fitted to be uſed here in *England*, then it hath (or may have) one ſort of Numbers (or Time) for finding the Hour and Minute, in the Summer Seaſon; another for Winter; and a third for the Spring and Fall; one when it lyeth undiſturbed in one and the ſame place; another (if you pleaſe) when carry'd always in a Rattling Coach. And on the other hand, if you carry it to Sea, then it has one for the *Torrid*, one for the *Frigid*, and a third for the *Temperate Zones*, &c. And yet ſtill but one and the ſame *Horologe*, and but one and the ſame *Indexes*. So that all manner of Natural Viciſſitudes or Contingencies whatſoever, may be Regulated or Æquated in and by the ſaid Numbers; and conſequently, the true Hour and Minute of the Day, where it is firſt ſet going, may be thereby as effectually found, as if no ſuch Impediments did at any time or place attend it, as aforeſaid.

And as for what may be ſuggeſted in relation to the Inequality between the Spring and Fuſie, if any ſhould be, it will be compenſated, in that there are five or ſix Windings up of them, to one Revolution in the *Horologe*. So that there is nothing wanting to compleat this Diſcovery, but to put it into Practice: And ſeeing the Charge and Trouble is very Inconſiderable; and the Legiſlature by *Act of Parliament*, hath been graciouſly pleaſed to Incourage hereunto, it is thought expedient to make this publick Propoſal, *viz.*

That

That if any one Perſon is willing to Engage in this ſo Noble an Enterprize, he will be readily received as a Partner, on ſuch Conditions as may be Reaſonably Concerted therein.

You may hear of the Author at Mr. Burleigh's *in* Amen-Corner, London.

MEMORANDUM.

1. All Departures muſt be reckon'd from *London*, if the Movement was there Set going.

2. That wheresſoever they are Set going, there muſt be a large and exact Meridian Line prepared by a Perpendicular, ſet up in an Horizontal Circle, as is Mathematically taught, *&c.*

3. That an Equal time be ſpent in Winding it up, as near as poſſible; for which no time need be allowed, if Equated for 10 or 12 Months; becauſe the time required will be the ſame for the ſame time, and greater for a greater, *&c.*

4. That the ſaid Movement be carefully kept in one and the ſame Temperature of Air, as near as poſſible.

5. That after this Movement is fully proved, if it ſhould not (by reaſon of any ſudden change of Air) agree to a Minute, yet it ought not in this reſpect to be altered or much regarded, becauſe the moiſtneſs of one Month, may compenſate the Dryneſs of another: So that by ſuch time as you are arrived to the end of your Voyage, the Movement may even Rectifie or Correct it ſelf.

6. It is to be noted, That if the Sun comes too ſoon to the Meridian, it will alſo come too ſoon to the Horizon; and therefore, Watch too faſt, or too ſlow, muſt be Added or Subſtracted, as aforeſaid.

7. That it be always wound up, as near as may be, at one certain time of the Day, (*viz.*) if at Sea, about Twylight, or Break of Day, as may be thought expedient. And if it ſhould happen to be omitted, ſo long as to ſtand ſtill; you muſt not ſet it going again, but by taking it aſſunder, and putting the two Indexes together, and bringing the Movement to the Meridian Line, as at firſt directed. Therefore when at Sea be careful of ſuch Omiſſions.

8. It is to be noted, That altho' every Minute of Time, does Anſwer to about 15 or 16 Miles *Engliſh*, under the *Equinoctial*; yet it is not above 9 or 10 Miles in our Latitude to one ſuch Minute. And altho' it be ſo many under the Equinoctial, yet *there* the Sun's Altitude will be taken very ex-

act, becauſe 90 degrees of Altitude, is for 6 hours of Time; whereas in our Latitude, it is but 62 degrees, for 8 hours of Time; both which Advantages will Facilitate the Practice. I ſhall at preſent conclude with acquainting,

That if a common Minute Watch (by Filing or Loading the Ballance, or otherwiſe) be made to go, or does already go, any unknown quantity of Time, either too Faſt, or too Slow; by this Device, we may find the Hour and Minute of the Day by ſuch a Watch, more exactly than can be done by the beſt timed common Watch whatever. And this even without touching it, other than by Winding up the Spring as uſual.

There are other Improvements that may be made of this Diſcovery, but I reſerve them to ſome other Opportunity.

The FORM *of the Book to be kept for each Movement, wherein muſt be entred the Numbers,* &c. *(which are to be found at the Returning of the Ship) for finding the Hour and Minute at* London.

The Movement, Number I. was firſt Set Going *Sept.* 4. 1704. and Then made one Revolution, in 5 days, 4 hours, and a quarter:

Degrees of Latitude. I.	Numbers to be found and uſed in finding the Hour at *London* II.	Hours ſpent in producing the ſaid Numbers. III.	Difference in Numbers. IV.	Seaſons in which the Ship was Sailing. V.	Time when the Movement was ſet in Motion & Try'd; at & after firſt Making or Cleaning. VI.	Numbers, ſhewing how the Motion is retarded by Foulneſs, on a Tryal of 10 Days at a time VII.	Days.
50	29276.2	240		*Autumn*	*Sep.* 16. 1714	29276.2	10
52	37962.4	432		*Winter*	*Dec.* 4. 1714	29272 5	10
44	37942.	430		*Spring*	*Ma.* 20. 1715	29264.	10
48	37912.2	431		*Summer*	*June* 1. 1715	29237.4	10
	Cleanſed *Sept.* 5. 1715.			Then made one Revol. in 5 days, 4 ho. and 1/8			
50	29274.2	240		*Autumn*	*Sept.* 5. 1715	29274.2	10
52	37957.9	432		*Winter*	*Dec* 17. 1715	29268.	10
44	37942.	430		*Spring*	*Ma.* 16. 1715	29264.	10
48	37907.5	431		*Summer*	*June* 8. 1716	29232.7	10

Note, That the Numbers to be uſed after *Cleaning*, (*viz.* after *Sept.* 5. 1715.) are found by Subſtracting or Adding the Difference between

the

the two Numbers in the Seventh Column (one that of *Sep.* [illegible]) and that of *Sept.* 16. (which is only [illegible]) out of the former Numbers to be uſed for the ſame Latitude, on which there will remain a[illegible] for the *New* Number to be uſed in Lat. 50. Deg. in *Autumn*, inſtead of the former, until the next Cleaning, (which muſt be only [illegible]) and ſo of the reſt, from one Cleaning to another. And this Method is to be uſed for the reſpective Latitudes, according as Obſervations ſhall be made therein, and Numbers found to anſwer thereunto.

Note alſo, That this Experiment may be ſufficiently Tryed and Proved by only two or three Voyages, to the South-Weſt parts of *Ireland*, or to *Newfoundland* at fartheſt.

But notwithſtanding what has been ſaid, it is chiefly to be noted, That altho' I have propoſed (for Example ſake) that the General Numbers ſhould be found, by Sailing to *Newfoundland*, *Virginia*, *Barbados*, &c. and returning again to a *Meridian Line* at *London*: Yet if the *Honourable Perſons* before-mentioned in this Title-Page, to whom the whole is moſt humbly ſubmitted, will pleaſe to appoint a Ship for this purpoſe, the ſaid Numbers may be much better found in manner following; (that is to ſay) By ordering that the ſaid Ship ſhall firſt make a true *Meridian Line*, at or near the Lat. of 60 Degrees; and thereby ſet the Movements going, in manner aforeſaid: After which let them ſail about 40 or 50 Leagues diſtant from the Shore, and there Cruiſe *Northward* and *Southward* for about a Month's time; after which let them return again to the ſame *Line*, and find the Numbers, and alſo enter them, as before directed. And having ſo done, let them make another *Meridian Line*, about 15 Deg. more Southward, and there do in like manner: And ſo at the like Diſtance to the *Equinoctial*. After which let them begin again, and repeat the ſame Proceſs for three or four times: By which means the Numbers will be found, and the different Motion of the Movement diſcover'd, for all Latitudes and Seaſons, as near as needful.

And being returned home, by theſe Numbers we may find the true *Difference* of Motion, in and for the ſeveral Latitudes and Seaſons. Which *Difference* muſt be entred in the 4th Column of the reſpective Books, reſerved for that purpoſe. By the help of which ſaid *Differences*, you may make as many Movements as may be needful, at any time; as alſo Books and Numbers peculiar to each Movement. The *Rules* for which will be imparted to any ſuch Watchmaker, as may Reaſonably deſire the ſame.

FINIS.

The Horologe Vniverſal:

OR

The Variable, and Infallible Horologer.